

The listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1-26. (Cancelled)

27. (New) A flow control device for controlling a flow of a fluid in a channel in which the fluid is supplied to a target where a pressure is lower than a fluid supply source, comprising:

a first opening and closing valve for opening and closing the channel;

a flow control component with a flow control valve mechanism that controls the flow of the fluid flowing through the channel by adjusting an aperture of the flow control valve mechanism, the flow control component including a flow detector generating a flow detection signal indicative of a flow rate of fluid through the flow control component;

an accumulator in which the fluid flowing through the channel can be held between the first opening and closing valve and the flow control component;

a pressure detector disposed upstream of the flow control component, the pressure detector configured to generate a pressure detection signal indicative of the pressure of the fluid in the channel; and

a control system for controlling operation of the flow control device, the control system receiving the flow detection signal and the pressure detection signal;

the control system having a normal operating mode in which the first opening and closing valve is open and the control system adjusts a valve drive signal so that the aperture has an opening size dynamically selected to regulate a mass flow rate based on a target mass flow rate and the flow detection signal;

the control system further having a test mode in which the first opening and closing valve is closed, the valve drive signal is set to fix an aperture size of the flow control valve mechanism during a measurement period and pressure change characteristics corresponding to decreases in pressure over time are monitored, wherein during the measurement period the pressure at the valve aperture is unregulated and a time-changing pressure at the aperture of the valve results in a non-constant flow rate of the fluid through the aperture; and

the control system determining deviations from standard levels of predetermined standard pressure change characteristics associated with the aperture size used during the measurement period of the test mode to calibrate flow rates of the flow detector.

28. (New) The flow control device of claim 27, wherein during the test mode a test fluid is used that is different from a process fluid used in the normal operating mode.
29. (New) The flow control device of claim 28, wherein the test fluid is nitrogen gas.
30. (New) The flow control device of claim 27, wherein during the test mode a vacuum is applied to a downstream side of an output of the flow control device.
31. (New) The flow control device of claim 27, wherein during the test mode there is an inversely proportional relationship for a given flow between pressure and aperture size.
32. (New) The flow control device of claim 27, wherein during the test mode there are a plurality of measurement periods to test a plurality of different aperture sizes with each measurement period testing one respect aperture size with the resulting pressure change characteristic being compared with a corresponding respective predetermined standard pressure change characteristic associated with the aperture size with the control system calculating deviations for the plurality of aperture sizes tested.
33. (New) A flow control device in accordance with claim 27 further comprising
a second opening and closing valve for opening and closing the channel on a side
opposite the first opening and closing valve relative to the flow detector, wherein
the control system is capable of adjusting an output level representing zero flow by the
flow detector.
34. (New) A flow control device in accordance with claim 27, further comprising
a temperature detector capable of measuring a temperature of the fluid on the same side
as the flow control valve mechanism relative to the first opening and closing valve, wherein
the control system further calculates the deviations from standard levels based on:
an initial pressure PO of the fluid at a first time in a certain time interval including
a time the channel is closed by the first opening and closing valve,
an absolute temperature T1 of the fluid at a second time period in the certain time
interval, and

a time period Δt from a time the pressure of the fluid reaches a certain first standard pressure P1 after the channel is closed by the first opening and closing valve until a time the pressure reaches a certain second standard pressure P2 which is different from the first standard pressure P1.

35. (New) A flow control device in accordance with claim 34, wherein the control system calculates the deviations from the standard levels based on a ratio between $PO/(T1 \times \Delta t)$ and a certain constant related to the standard level.

36. (New) A mass flow control device comprising:

a flow control component that has in a channel through which a fluid flows, a flow detector for detecting a mass flow of the fluid that flows through the channel and outputting a flow signal; and a flow control valve mechanism for controlling the mass flow by adjusting a valve aperture by means of valve drive signals, and in a normal mode of operation controls the flow control valve mechanism based on an externally input flow set signal and the flow signal to regulate a mass flow rate, wherein;

the mass flow control device further comprises a deviation measurement/control component which:

has in the channel a first opening and closing valve for opening and closing the channel; an accumulator in which the fluid flowing through the channel can be held between the first opening and closing valve and the flow control valve mechanism; and a pressure detector for detecting a pressure of the fluid and outputting a pressure detection signal, and

controls the first opening and closing valve and the accumulator and the pressure detector to perform a mass flow test operation based on:

(i) the measured pressure changes determined during a measurement period when the first opening and closing valve is closed and the valve aperture remains fixed at a selected aperture opening by fixing the valve drive signals; and

(ii) predetermined standard pressure change characteristics associated with the selected aperture opening;

(iii) determines deviations between the measured pressure changes and the predetermined standard pressure change characteristics to calibrate the flow signal for the normal mode of operation;

wherein during at least the measurement period the pressure at the valve aperture is unregulated so that a decreasing pressure at the aperture results in a corresponding decreasing mass flow rate through the selected aperture opening.

37. (New) A mass flow control device in accordance with claim 36, wherein a second opening and closing valve for opening and closing an outlet side of the channel during a zero point measurement is executed is provided in the channel.
38. (New) A mass flow control device in accordance with claim 36, wherein the first opening and closing valve, the accumulator, and the pressure detector are provided further upstream than the flow detector and the flow control valve mechanism.
39. (New) The flow control device of claim 36, wherein during the mass flow test operation a test fluid is used that is different from a process fluid used in the normal mode.
40. (New) The flow control device of claim 38, wherein the test fluid is nitrogen.
41. (New) The flow control device of claim 36, wherein during the mass flow test operation a vacuum is applied to a downstream side of an output of the flow control device.
42. (New) The flow control device of claim 36, wherein during the mass flow test operation there is an inversely proportional relationship for a given flow between pressure and aperture opening.
43. (New) The flow control device of claim 36, wherein during the mass flow test operation there are a plurality of measurement periods to test a plurality of aperture openings with pressure change characteristics for each aperture opening being compared to respective predetermined standard pressure change characteristics associated with each respective aperture opening.
44. (New) A method for adjusting a flow control device that controls a flow of a fluid in a channel in which the fluid is supplied to a target where a pressure is lower than a fluid supply source, the flow control device comprising; a first opening and closing valve for opening and closing the channel; a flow control component with a flow control valve mechanism which controls the flow of the fluid flowing through the channel by adjusting an aperture of the flow

control valve mechanism according to a valve driving signal, and an accumulator in which the fluid flowing through the channel can be held between the first opening and closing valve and the flow control valve mechanism, the method comprising:

during a normal operating mode delivering a fluid with a mass flow rate of the fluid regulated by adjusting the valve aperture based on a first signal indicative of a target mass flow rate and a second signal indicative of a measured mass flow rate;

in a test mode, performing a verification of the accuracy of the measured mass flow rate, including:

a) fixing the aperture of the flow control valve mechanism at a selected aperture opening by fixing the valve driving signal;

b) closing the channel using the first opening and closing valve;

c) measuring changes in a pressure of the fluid in the channel at a predetermined first position on a same side as the flow control valve mechanism relative to the first opening and closing valve after the steps a) and b), wherein the aperture remains fixed at the selected aperture opening during the step c) and wherein the pressure at the aperture is not regulated during step c) such that decreases in pressure generate a resultant decrease in mass flow through the selected aperture;

d) calculating a deviation of the flow controlled by the flow control component from a standard level associated with the selected aperture opening based on comparing the measured pressure changes to predetermined pressure change characteristics ; and

e) determining from the deviation if a flow calibration of the flow control component is required to achieve a target mass flow rate accuracy and generating a required flow calibration based on the deviation from the standard level.

45. (New) A method in accordance with claim 44, wherein

the flow control component further comprises a flow detector capable of measuring the flow of the fluid flowing through the channel on the same side as the flow control valve mechanism relative to the first opening and closing valve, and controls the flow of the fluid flowing through the channel by adjusting the aperture of the flow control valve mechanism based on a target flow and the flow measured by the flow detector,

the step e) comprising the step of adjusting an output level representing the flow by the flow detector based on the deviation from the standard level.

46. (New) A method in accordance with claim 45, further comprising the steps of:

f) closing the channel using the first opening and closing valve, and closing the channel using a second opening and closing valve on a side opposite the first opening and closing valve relative to the flow detector;

g) reading the output level representing the flow by the flow detector while the channel is closed by the first and second opening and closing valves; and

h) adjusting an output level representing zero flow by the detector.

47. (New) A method in accordance with claim 44, further comprising:

in the test mode utilizing a test fluid different from that used in the normal operating mode and applying a vacuum downstream of the flow control component.

48. (New) A method in accordance with claim 44, wherein

the step d) further comprises the step of

calculating the deviation from the standard level based on:

an initial pressure PO of the fluid in the first position at a first time in a certain time interval including a time the channel is closed by the first opening and closing valve;

an absolute temperature $T1$ of the fluid in a predetermined second position on a same side as the first position relative to the first opening and closing valve at a second time in the certain time interval; and

a time period Δt from a time the pressure of the fluid reaches a first standard pressure $P1$ at the first position after the channel is closed by the first opening and closing valve until a time the pressure reaches a second standard pressure $P2$ which is different from the first standard pressure $P1$.

49. (New) A method in accordance with claim 48, wherein

the step d) further comprises the step of

calculating the deviation from the standard level based on a ratio between $PO/(T1 \times \Delta t)$ and a certain constant related to the standard level.

50. (New) A method for testing a mass flow control device, wherein the mass flow control device has a channel through which a fluid flows; a flow detector for detecting a mass flow of a fluid that flows through the channel and outputting a flow signal; and a flow control component with a flow control valve mechanism that controls the mass flow by altering a valve aperture by

means of valve drive signals; and a deviation measurement/control component which has in the channel a first opening and closing valve for opening and closing the channel; an accumulator in which the fluid flowing through the channel can be held between the first opening and closing valve and the flow control valve mechanism; and a pressure detector for detecting a pressure of the fluid and outputting a pressure detection signal, and controls the first opening and closing valve and the accumulator and the pressure detector to perform a mass flow test operation wherein the pressure of the fluid is not regulated at the valve aperture during at least a portion of the mass flow test operation; wherein the testing method comprises the steps of:

- setting a verification flow by fixing an aperture of the flow control valve mechanism at a selected aperture opening by fixing the valve drive signal;
- ensuring a stable flow of a fluid for the test in the channel;
- detecting a pressure of the flowing fluid and a temperature of the accumulator to determine an initial pressure and an initial temperature respectively;
- closing the channel using the first opening and closing valve;
- measuring changes in a pressure of a fluid flowing from the accumulator after the closure of the channel while the aperture of the flow control valve remains fixed at the selected aperture opening according to the fixed valve drive signal, wherein the measured pressure changes are indicative of changes in flow rate of the fluid through the aperture; and
- performing a comparison of the measured pressure changes to a predetermined standard pressure change characteristic associated with the selected aperture opening; and
- calibrating the flow detector using the comparison,

wherein in a normal mode of operation the calibrated flow detector is used to provide an indication of how the aperture is to be adjusted to achieve a target mass flow rate.

51. (New) A method for testing a mass flow control device in accordance with claim 50, further comprising calibrating the flow detector automatically based on the comparison.

52. (New) A method for testing a mass flow control device in accordance with claim 50, the testing method further comprising testing a plurality of different aperture openings and for each aperture opening performing a comparison of the measured pressure changes to a predetermined standard pressure change characteristic associated with the aperture opening to generate a set of comparisons, and calibrating the flow detector using the set of comparisons.

53. (New) A method for testing a mass flow control device in accordance with claim 50, further comprising, before the step for setting the verification flow, measuring a zero point by blocking the flow of the fluid flowing in the channel.

54. (New) A flow control device for controlling a flow of a fluid in a channel in which the fluid is supplied to a target where a pressure is lower than a fluid supply source, the device comprising:

- a first opening and closing valve for opening and closing the channel;

- a flow control component with a flow control valve mechanism for controlling the flow of the fluid flowing through the channel;

- a pressure detector capable of detecting a pressure of the fluid on a same side as the flow control valve mechanism relative to the first opening and closing valve; and

- a deviation measurement/control component for calculating a deviation of the flow controlled by the flow control component from a standard level, the device further arranged so that a fluid flow path between the flow control component and pressure detector consists of one of a gas flow tube or a mass flow detection system; wherein

- the deviation measurement/control component in a test mode:

- fixes an aperture of the flow control valve mechanism at a selected aperture opening and measures changes in the pressure using the pressure detector while the channel is closed by the first opening and closing valve, wherein the aperture remains fixed at the selected aperture opening during the pressure change measurement and the pressure is unregulated at the aperture such that the mass flow decreases with decreasing pressure, and

- calculates the deviation from the standard level associated with the selected aperture opening based on the measured changes in the pressure to calibrate the flow.